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Haizhong An
China University of Geosciences, Beijing

Wenjing Yu
China University of Geosciences, Beijing

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China University of Geosciences, Beijing

ABSTRACT

Under the influence of "Digital Earth", information technology becomes mature, making the procedure of information processing more systematic and integrated. The application and integration of technology like GIS technology, communications and computer network technology, Database Technology, artificial intelligence and expert system technology will play important impact on content of resource information management. In order to discovery the content of impact, we analyze the present situation of mineral resource management information system (MRMIS), summarize the problem. By comparing and analysis, we know the impact of integrated application of IT involves service target, information processing methods, system structure, system function and service content of system. By this, we forecast developing prospect, expected to provide some referred value for development of mineral resource information management.

INTRODUCTION

As a kind of non-renewable, precious, limited resource, mineral resources are a major component of national resources. They are the material foundation of national economy and social development, also the basic source in human life and production. Therefore, standardization and scientific management not only provides the guarantee for efficient use and exploitation of mineral resources, but also is guaranteeing directly relating to social sustainable development.

Mineral resource information can be described as a data, expressing and controlling state and methods of resource movement. As long as there are mineral resources, there is it, reflecting the absolute and universal nature of mineral resource information. However, the resources in different regions have different existence, reflecting the relative and special nature of mineral resource information.

As a kind of resource information, mineral resource information has these features:

Accurate: this is also the requirement of information. In certain areas of scientific research, the requirement about accuracy of information is often high. For instance, when we describe the specific location of a deposit, we must give the detailed longitude and latitude. Any tiny mistakes may cause trouble to research.

True: Describing the features of mineral resource is commonly used in management carried by national organization, scientific research and disseminating knowledge. When the information is reported, it must be true.

Variable: With the change of environment, some nature of mineral resources can take up minor changes. A period of times later, these changes may become so apparent that impact on the essential character. The variable nature of the information supplies much facilitation for the research.

Continual: Based on the changes of resource feature, updating data should be done every so often when storing the information, guaranteeing the accuracy of information.

Systemic: when mineral resource described, many words will be come up, like longitude, latitude, location, structure etc. Resource information must consist of all the features, benefiting all kinds of researching works.

Data going together with graph: mineral resource information has its spatial and attribute feature. When it is described, data and graph may be used together.

Mineral resource information management involves the social practice procedure of mineral resource information. It collects, stores and disposes information, as well as supplies service to it, by a variety of ways to plan, organize, command, control and coordinate, with the aim to control the mineral resource development by using human, material, finance resources effectively. Mineral resource information management is the product and need of social development. It reflects the progress of the mankind to some extent. It covers the entire process of mineral resource information collection, organization, processing, storage, distribution and services.

As the rapid expansion of information, mineral resource information management becomes increasingly complex. The requirement of managing method is higher and higher. With limited space resources, how to maximize the economic benefits is the common question faced by mineral resource information management.

With the rapid development of scientific technology, the traditional management methods no long meet the development of mineral resource industry. As too many people in our country, even if China is rich in mineral resources, the amount of mineral resources every people shared remains low. Yet the traditional manual means of management is inefficiency, consuming too much time, slowly updating and inquiries. Sometimes, even the inquiries result is outdated far from the urgent need of mining area. Facing to this situation, we need a rapid, accurate and efficient system to guide the industry. If the mineral resource information can be stored in the computer in the form of electronic data, on the basis of the modern information technology, we can deal with the above problem to some degree. So the establishment of resource information system seems reasonable (Chen, 2003).

Since mineral resource information is a kind of geographic information, mineral resource management information system(MRMIS) can be a subsystem of resource information system. With the rapid development of information technology, people's demand of system function becomes increasingly high. The system only using traditional MIS (management information system) technology to develop will be lack of management ability on spatial data. There will be some difficulties in integration of spatial and attribute data, which affects the dynamic query and analysis and creates obstacles on decision support.

In the following section, the present situation and the problem of MRMIS, the impact on the system caused by the application and integration of information technology will be discussed.

Definition and Meaning of MRMIS

Mineral resource information system(MRMIS) is an information system that collecting natural mineral resource date (or relevant information); processing, analyzing and explaining the data by information technology; then outputting the information which helps people managing and decision. Ideal MRMIS should include: efficient and entirely digital function about collecting, managing and decision. The ideal ones usually should include three kinds of structures: resource decision support system, functional information system and business information system (Zang, 1997).

Resource decision support system provides service helping the high-level making decision. Decision support system supplies decision-maker a simulating procedure of making decision and the environment of decision support by providing some mineral resource management programs, using the data and function of functional information system and business information system.

With the aim of high efficiency of processing information, functional information system can provides the information and program that decision needs by collecting, processing and synthesizing information for the middle functional department. It also has the function that it can retrieve and statistics resource information and can analyze the relevant professional model. A large amount of information in this system is from business information system.

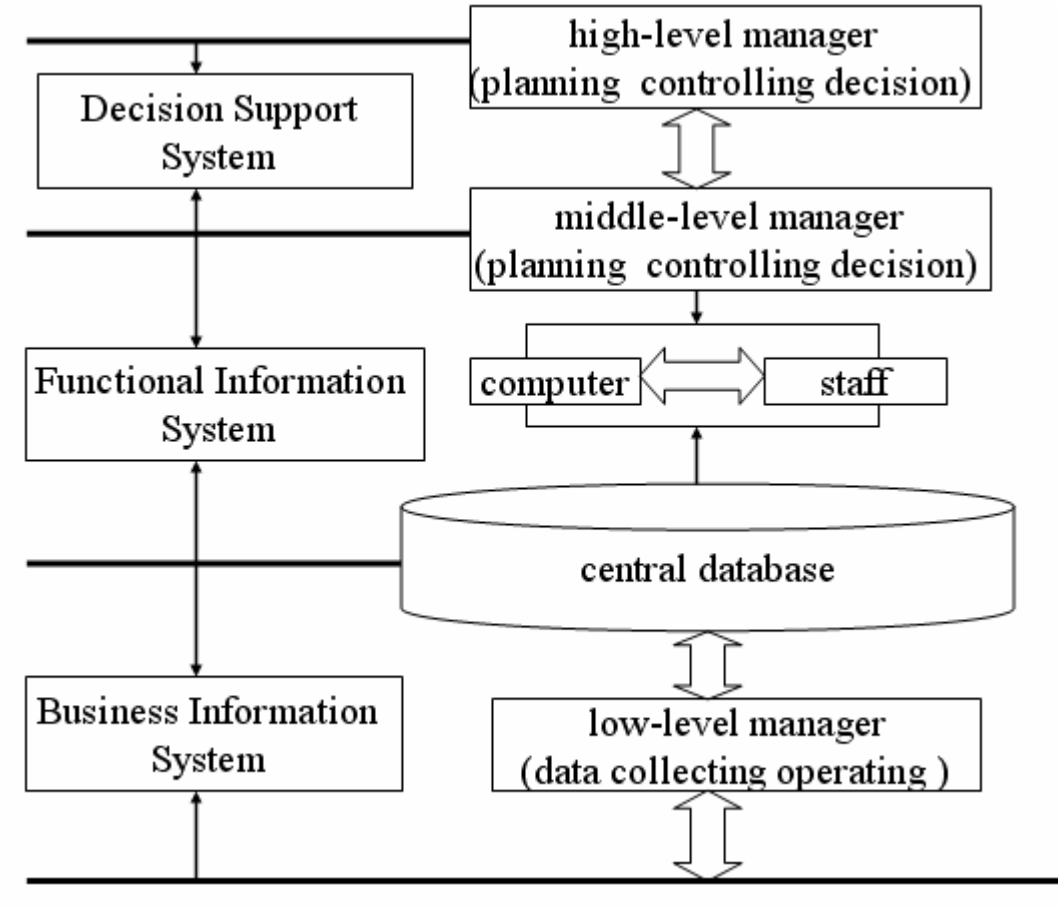
Facing to the low-level, business information system collects and processes all the information from low-level continually. The information is stored, often in the database. This system can supply the information needed by the business of low-level department. Its target is processing lots of information rapidly, timely and accurately and making daily business process automatically. Instead of busy and repetitious daily business, this automatic

information system can replace much manual work. However, it supplies the most detail information for the system above.

In three levels above, business information system is the lowest in application, Resource decision support system is the highest, functional information system is between these two. In a huge information system project, these three systems are often used together (Xu, Wei & Yang, 2002).

The conception structure of ideal MRMIS is illustrated in figure 1.

Figure1: Conception structure of ideal MRMIS.



THE PRESENT SITUATION OF MRMIS

Maximize Economic Profit

In addition to some common ideas, developing countries are more concerned about their basic problems faced present in the field of resources management. Our country gives the full consideration for the production, exchange, consumption and the market of the mineral resources when managing it. However, developed countries have started to consider landscape assessment, the social capacity of carrying resources and anticipate the behavior problem of resource managers and users.

In china, provincial departments use resource environmental information mainly to guide production, set production targets, predict future trends and develop planning. According to the survey, the resource information used for production guidance is about 60%, for production targets is about 50%, for the forecast is about 45%. From the

application of information, every department's database is mainly used for internal or the system. The information which used to know about other department is only 20%. All of these reflect the present situation: the information is only belonged to the department which occupied it (Cao & Wang, 2001).

Currently, MRMIS has not been fully updated. Most of them can only be able to realize individual management, focusing on local economic interests. Although various departments at different levels have their own basic MRMIS, the establishing purpose is to a large extent based on guiding production, taking economic profit maximization principle for using information too. We can not deny that information system is used to guide production. But only limiting to the unilateral, low-quality, static management, is not benefit for the whole development of MRMIS.

Machine-centered and Facing the Internal Managers

The service target of existing MRMIS is manager or the internal staff. In order to avoid a large number of paper work, management departments gradually beginning to establish resource information system to support management, the purpose simply to save manual labor time and raise working efficiency. In some departments, the service target is even the statistician, just bringing them some facilitate. Such a system always makes the machine as center.

Computerized Manual Labor

Traditional MRMIS is based on small database technology. The application is often on statistics of local mineral resources and statistical information seldom involves spatial information, difficult for spatial data analysis and realizing the data visible. Although the automation is achieves on the face, the collection and transmission of information has a mix of manual labor. Since china has vast area and more scattered distribution of mineral resources, a lot of information is acquainted by geological worker's hard working. Some relevant production of maps also needs hand-drawn, or the computer-aided mapping out of database. The utilization of geographic information system only stays in partly management for static space information, not able to manage dynamically. GIS can't cooperate with MIS perfectly in data collecting and transmission.

Close and Lack of Elasticity

The present MRMIS is close and one-way. Lack of commonality exists among information systems of different management departments. Because every department set up their own types of mineral resource database, lack of inter-departmental joint additionally, these databases or information system are different in standards and criterion. The accessibility of much data is unknown. The databases built by computer staffs are at different levels are often can not be able to work as staff's mobility. Lack of flexibility causes great human and material waste.
In addition, because of the simple function of system, one-way primary data and less synthetic information, system is weak in analysis, forecasting, simulation and planning functions and difficult to achieve a two-way flow of information.

Simple Function

Since mineral resources have spatial and attribute data, the management information system involving mineral resources is not same as general management information system. At present, many MRMIS was still working in the data collection, storage, query, statistics, simple analysis and statistical management, lack of space data operation and management. In the condition that artificial intelligence and expert system technology is maturing, the system only achieving function of simple data manipulation is not perfect.

No Common Standard and Low Technical Level

At the aspect of management mechanism, the unification of information standard and criterion directly affects the mineral resource information management. There is no standard to reference to when the system created. On the term of management sector itself, it functioned a little. But on the whole, there is no overall effect as the lack of systematic. Now, there is no an authoritative department guiding the computer application in sectors. The department is doing its own database, making the difficulties when users facing to the different database to judgment.

All of these let the whole mineral resource information management seem very irregular.

Only Providing Text, Data and Picture

Since the developing technology restriction, most mineral resource information system often can only provide text, data and picture when it services, showing a rather monotonous form. When the system used to scientific research, it is enough. But for the trends of integrated development, such service can not meet the situation. When the public lack of professional knowledge uses the system, they want a simple and clear service manner. The multimedia techniques like video may solve these problems to a certain extent.

THE PROBLEM

Geographical information expresses the geographical factors or the quantity, quality, distribution characteristics, contact of the material or some figures, text, images. Mineral resource information is belonged to the scope of geographical information. Therefore mineral resource information system is essentially a kind of subsystem of resource information system. Now, its main problem has two aspects.

As the impact of constructing management information system in the early time, people think resource information system is the same with common management information system. They create some graphic system by CAD or implement some general relational database management. It seems to manage the graphic data, but is lack of managing ability on the space data. We need management not just showing the results. These systems can not combine space data and attribute data to achieve the dynamic query and analysis.

The developing methods not flexible enough, the code not be reused perfectly makes the system unsatisfactory and inefficient. The interface is designed so simply that the designer's imagination can not be played well. At another aspect, there are some difficulties in application of GIS in major resource management projects, "digital land" and "digital earth". [1]

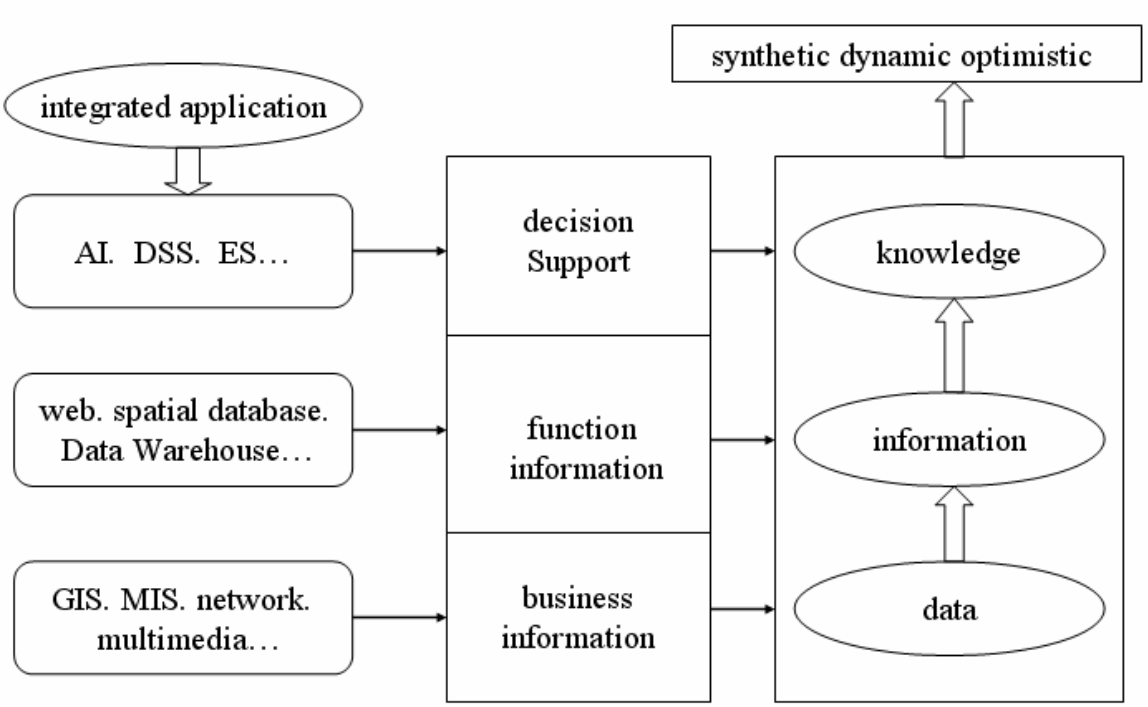
We may discover that in the design process, the difficulty to realize integrated and dynamic system is caused by information technology used single. The professional mineral resource information system and information exist commonly in every independent managing department. The managing department has the information about its quantity, mining condition, mining potential etc. scientific and research department know much geographic information, like the location, geological structure, potential geological disaster etc. This professional information reflects the mineral resource information in different fields objectively from the different aspects. If we can synthesize and perfect this information, using the integrated information technology to establish mineral resource information system is feasible (Liu, 2000). In strategic perspective, under the background of "digital earth", the goal of mineral resource information system is an integrated, dynamic and sharing management system. In condition of limited resources, using modern management methods to achieve the effective management is the significance of resource management. With the development of information technology, we can see some hope. If information technology can be applied integrally in the mineral resource management system, the goal may come true more easily.

Impact of Some Information Technology on MRMIS

Pivotal Technology Referred by Each Part of MRMIS

According to the development rule of resource information system, we know the system can be divided into three parts. They are the system, system and decision support system. The first part business information solves problem of data gather and share, to achieve target that the information system can provide any data what needed at the mineral resource work. The second part function information make data to useful information, can answer specific question quizzed by applications, namely provides information of appointed subject to applications. The third part abstracts knowledge from information, provides doable solving scheme supported by decision supporting technology and so on. Integrate application of information technology on every part can cause the impact on the service target, information processing methods and other aspects. The impact on the parts of system is illustrated in figure 2.

Figure 2: The impact of integrated application of IT on the parts of system.



The Technology Referred by Business Information System

GIS is an important supporting technology to obtain, store and manage, renew, analyze and apply spatial data. It is one of pivotal technology of digital because the most of data referred by the mineral resource information are spatial data concerned with geography position and other relevant information. GIS coordinating with MIS perfectly can make the data obtain easier, realizing the automation in the whole procedure of data processing. In addition, the geographical picture can be gained more easily by GIS.

Computer network technology is an important foundation of the MRMIS. It is a foundation guaranteeing of transfers for the mineral resource information. As we know, when the different level report mineral information, using this technology can avoid the much time caused by the distance. People in different place can enter the system to input the information. At the same time, they can obey the unified standard form to store the data, letting the system seem to be organized.

Multimedia can change the simple service content. It provides the voice or video to make the expression of information much colorful.

The Technology Referred by Function Information System

Data warehouse technology is data aggregate. it supports decision-analysis processing of organization, faces subject. The data warehouse provides good data foundation to the system, facilitating the dynamic query. This technology can raise efficiency that application system call data, and makes going along complicates data analysis research possibility.

Web creates a platform for the system. On this platform, the system becomes human-centered, no longer supplying service for the internal staffs. People can gain the information needed easily. It creates the convenient for the knowledge dissemination.

Spatial database technology is used to store the spatial database. The spatial data is data figuring information of position, sharp, size and distributing character of spatial entity. Most of the mineral resource data are data correlating with spatial position. It can get twice the result with half the efforts using distributed spatial database technology administer and process the mineral resource data.

The Technology Referred by Decision Support System

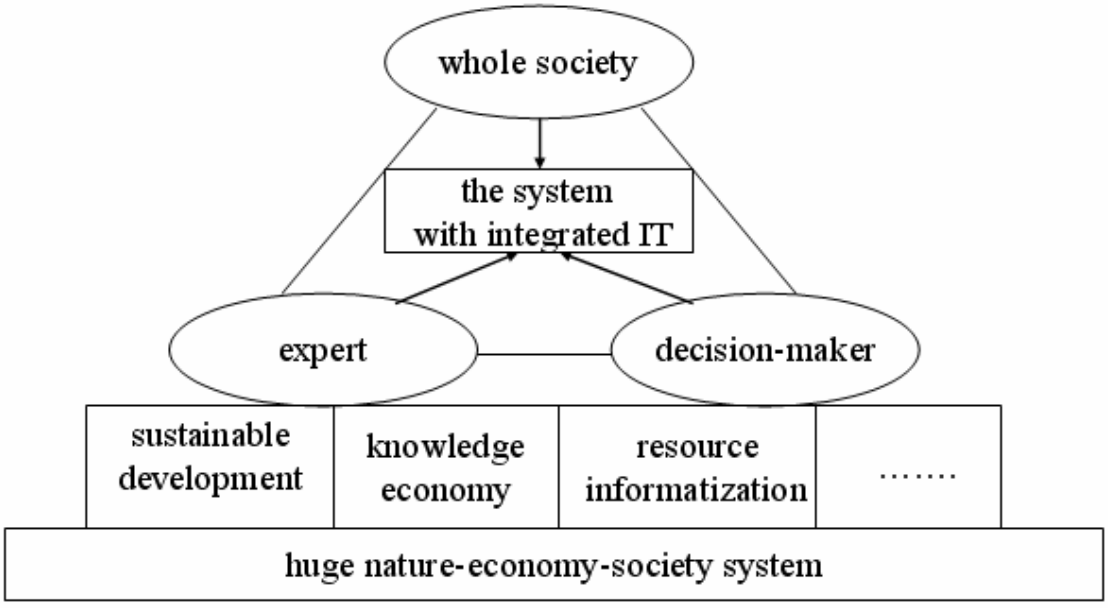
Artificial Intelligence simulates intelligent behavior of human brain using computer. The **export system** simulates thinking process of human export solving problem to resolve all kind of problems inside domain by one of AI. There are a lot of problems needing solved by export in the domain of the water resources. AI will provide help for solving these problems.

Decision Supporting System Technology is human-machine system supporting decision activity and have intelligence function based on administration science, operational research, cybernetics and behavior science means of computer technology, emulation technology and information technology aiming at half- structured decision problems. DSS can provide necessary data, information and background information for decision.

The Impact Caused by Integrated Application of IT

Service Target, Instead of manages or internal staffs, MRMIS with integrated IT serves decision-maker, expert and the whole society. The system based on web forms a widely platform, with which the system can provide more wonderful service. It provides much facilitation for sustainable development and knowledge economy. The system is human-centered, not machine-centered, becoming more optimistic. The conception model of service target by the system with integrated IT is illustrated in figure 3.

Figure3: Conception model of service target by the system with integrated IT.



Information Processing Method

GIS cooperating with MIS perfectly automates data collecting. In this condition, computers do not take place of the manual work simply. People even don't need to input information by manual work. Moreover, the data may be more true and accurate, avoiding the mistakes caused by people. Advanced database and data warehouse technology make data be stored in strict structure and rule, facilitating the realization of dynamic query. The advanced method of

information processing benefits operation speed of system, raise the working accuracy and efficiency.

System Structure

With the integrated web and communication technology, system is not close and one-way. Information transmission channels maintaining smooth, the role of information feedback is visible. The whole system has a certain degree of flexibility, assuring the versatility.
In addition, standard and criterion seem to be feasible as the web. According to the standard, system is created more orderly. All the sub-system can play the important role in every different level department in different places. At the same time, the also can form a whole and synthetic mineral resource information belonged to the nation. It must be easier to realize the expansion of content and function when it needed with unified criterion when system built.

System Function

According to the development rule of resource information system, we can divide the procedure into three phases. They are the preliminary, basal, and full phase. The system owning the function of decision can be the full one. It abstracts knowledge from information, provides doable solving scheme supported by decision supporting technology and so on. With AI and ES technology, system can supply a decision-making environment for decision-maker, at the same time, it supply some referential methods according to arithmetic base and model base. Not only realize the data operation, the system can provide information and knowledge.

Service Content

As we know, GIS can gain geographic pictures, multimedia can show them perfectly. Traditional system only shows text, data or some picture as the result. With the development of digital industry, more and more different people will use MRMIS. These people may have different level of knowledge and experience in mineral field and their demanding can be different. The trend of demand may be more and more increasing. But the principle is only one---system must use a suitable method to express information they understand. With multimedia, system can supple voice or video for users. Even some recondite geological knowledge can be accepted by children. All of these can benefit the dissemination of mineral resource knowledge and situation of national mineral resource. In the condition of limited resource, it is helpful for raising consciousness of resource protection.

PROSPECT OF MRMIS

From the early 1960s', Canadian scholar R. F. Tomlinson (1984) developed the "Canadian geographic information system" (CGIS), (spatial database whose main content is land at first). After thirty years' discovery and practice in many countries, resource information system has come out of laboratory, entering the field of resource development and management directly, taking up widely developing prospect. Netherlander called P. A. Burrough (1986) issued the first composing in this field, which introduced resource information system technology systematically. After this, a number of achievements appeared (Ripple, 1987; Bracken & Webster, 1990; CISM, 1989) and they got progress at aspects of resource database, recourse mapping system, access to resource data and decision support of resource development. Expert System especially became hot point of research. In the past several years, dozens of Expert Systems has appeared (Robinson, 1991), applied in some special resource intelligent analysis and management Tomlinson, 1989).

With the development of information technology and integrated application of it, MRMIS is expected to progress in the following areas.

First, the synthetic function of MRMIS will be improved continually. The system will develop rapidly as its potential synthetic ability. But so far, this function is not fully expressed, most one has stayed in the application level of providing information query, automatic resource mapping and simple analysis. We can predict that it will continue to strengthen the analysis function so as to show the truly integrated function that many scholars try their best to develop resource analysis model.

Second, input and output of MRMIS will be perfected. Remote sensing techniques and investigation in wild may

provide continuous information link for the system, realizing the dynamic monitoring and controlling of mineral resource. However, this progress directly depends on the popularity extent of remote sensing technology.

Third, mineral expert system is expected to develop rapidly. The developed ones universally have been limited in application, mainly because of users' higher demanding. What is expected to exceed are intelligent user interface, retrieval technology of spatial database and high-precision image classification. Especially the expressing ability of resource expert system will gain great progress.

Fourth, a number of high-level typical small systems will appear. Many information system experts have been aware of that the knowledge learnt from creating small system can be used in promoting higher level system. Developing more typical system which stresses unified problems but using the different methods will help compare and analysis to make the decision of developing senior systems (Qin, 1994).

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